Globelics

UNIVERSITY-INDUSTRY INTERACTIONS IN BRAZIL: MAPING RESEARCH GROUPS DATABASE FROM 2004

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INTRODUCTION

The innovative activity is an important instrument to promote countries and economies development (Schumpeter, 1982). It's important to stress that it's not an individual effort but a result of a collective process (Nelson, 2004). Inside this dynamic that university-industry interaction should be understood and investigated.

The importance of the university-industry linkage has been frequently discussed in the literature about National System of Innovation (NSI). In the innovative process, firms play an important role since they generate new technologies with the support from others institutions. In this context, universities develop and train human resources and generate scientific knowledge that can be used in firms' innovative activities. So, interactive relationships between firms and universities can be a powerful source of innovation and news technologies generation.

Based on the assumption that university-industry (U-I) interaction is specific to each country, as it depends on national Science and Technology (S&T) infrastructure, the aim of this paper is an initial effort to map this interaction in Brazil by university's perspective. So, it will be analyzed the database from CNPq's Directory of Research Groups. The unit of investigation is the research groups that declared any relationship with productive sector in 2004.

CNPq, is a 50-year-old organization of the Brazilian Ministry of Science and Technology, responsible for distributing research grants to the Brazilian scientific and technological communities. Its Directory of Research Groups is a database, which started to be collected in the early 1990s and is renewed every second year. It comprises detailed information about research activities in Brazil using the ´Research group' as the unity of analysis. The directory provides an excellent proxy for studying research activities in Brazil, even though the adherence to it is voluntary[3]. Although there are limitations intrinsic to information collection, the database supplies some importance evidence from recent university-industry interactions in Brazil that will be used in this paper.

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[3] In fact since the late 1990s research groups' leaders in public universities have been implicitly forced to send information to Directory, because their access to government funding implicitly depends on the data informed in this database.

Beyond this introduction, the article has 4 more sections. The next section summarizes the background from university-firms interactions embracing the main contributions of academic activities to firm's innovation and the sectoral specificities in university-firms interactions. Section two describes the database and the methodology used to construct it. Section three shows university-firms interactions in Brazil in different level of investigation being in state level, knowledge area, size of the firms and interactive disciplines areas and firms sector of activity. Finally remains the conclusion of the paper.

1 - UNIVERSITY-FIRMS INTERACTION: BACKGROUND

Nelson and Rosenberg (1993) stress that to understand the National System of Innovation (NSI) concept it should be taken in account the meaning of each world. 'National' refers to the system of national institutions that support and encourage technology innovation. 'System' refers to a set of actors and /or institutions whose interactions will shape the innovative performance of a country, specially the performance of national enterprises. And 'innovation' represents the influence of national technology capacities to create, diffuse and implement new process and products. Technology advance is a rolling process that cannot be realized individually.

To Nelson and Rosenberg (1993, p.3):

"There clearly is a new spirit of what might be called 'technonationalism' in the air, combining a strong belief that the technological capabilities of a nation's firms are a key source of their competitive process, with a belief that these capabilities are in a sense national, and can be built by national action."

NSI literature emphasizes the role of each national institution in fostering national competition and technology development. University-industry relationships are, according to this view, strongly conformed by national specificities regarding the pattern of productive specialization (the 'structural absorptive capacity') and the specificities of S&T infrastructure institutions. Strong national idiosyncrasies shape path dependent U-I interaction and hence the effectiveness of public investments in basic research.

The literature regarding developed countries suggests five main contributions of academic activities to firms' innovations:

1. Knowledge of a more general kind: academic research provides concepts, techniques;
2. And ideas to be used later by industry in a variety of ways (Nelson, 1990);
3. Specialized knowledge related to the technological area of the firm (Klevorick *et al.*,1995). Empirical evidence suggests that academic activities stimulate and increase R&D internal to the firm, complementing (and not substituting) them (Rosenberg e Nelson, 1994), as well as aid firms to overcome size restrictions and increase flexibility (Acs *et al.* 1994; Rothwell 1991).
4. Training of scientists and engineers capable of dealing with innovation problems of firms (Nelson e Rosenberg, 1993; Pavitt, 1998; Klevorick *et al.*, 1995). Of particular relevance is the network of personal relations used for problem solving in industry brought by this people;
5. New instruments and scientific techniques. (Rosenberg 1992);
6. Setting up of new firms, *spin-offs* of academic research;

The innovative process varies across sectors in terms of its dynamics, rate of technology change, interactions and partnership, access to knowledge, structural organizations and institutional factors. There is a significant difference in technology rate growth in each sector (Klevorick *et al*., 1995). Some industrial sectors are characterized by fast changes and radical innovation others by small chances and incremental innovation. So university-firms interaction is particular to each sector (MOWERY & SAMPAT, 2005), being more intensive in some sectors as the biomedical area, for example.

Malerba (2004) presents the concept of "Sectoral System of Innovation" and reinforce the interactions between actors:

"In various ways, they [non-firms organizations] support innovation, technological diffusion, and production by firms, but again their role greatly differs among sectoral systems. In several high technology sectors, universities play a key role in basic research and human capital formation, and in some sectors (such as biotechnology and software) they are also a source of start-ups and even innovation" (MALERBA 2004, p. 9).

Pavitt (1984) also stresses the importance of sectoral specificities, proposing taxonomy based on innovative and technological structural patterns, being: supplier dominated, production intensive and science based. Latter, the category *information intensive* were introduced. The supplier-dominated sector shows low R&D efforts and weak engineering capacity. They, generally, acquire technology by their suppliers. The production intensive sector has an expressive engineering capacity that helps in solving problems and proposing improvements in products and process. In the science based sectors the source of technology are internal R&D activities that frequently is monitoring universities and research institutes knowledge.

Therefore sectoral differences also require distinct organizational structures inside firms, and institutional factors as regulation and intellectual property can vary their role and importance. It is important to consider these differences when trying to understand the relationship between universities and firms and the intensity of this linkage.

Pavitt (1984) analyzed around 2000 British firms in terms of innovative efforts, size, diversification and others. The data showed that electrical and electronic engineering sector produces 80% of total innovation that it uses and 60% from innovative process are product innovations. Textiles, in a different way, produce 16% of innovations used in sector and 32% are product innovations. The author also analyzed the size distribution if innovating firms in different sectors. In chemical and automobile sector innovative firms, frequently are large firms, with more than 10.000 employees. In instrumental and mechanical engineering the predominant innovative firms have until 998 employees (table 3, p. 351).

Meyer-Kramer and Schmoch (1998) investigated the features of university-firms interactions in science-based sector in Germany. They found that distinct academic disciplines and industrial sector do not have the same interest and do not face the same problems. Areas like 'Production Technology' and 'Microelectronic' have a higher percentage of applied research while disciplines as chemistry and biotechnology have a higher percentage of basic research. 'Production Technology' and microelectronic have also higher percentage of profits from research results, 25% and 18% respectively. In chemistry and biotechnology the same were 11% e 12% respectively.

The survey shows collaborative research and informal contracts as the more frequent channel of information exchange. In 'production technology' research contracts were the most important channel followed by collaborative research. In chemistry personal education and training were considered important as information channel together with informal contacts and collaborative research.

Surveys realized in north American firms, in turn, shows that universities tend to be more relevant for firms to complete than to suggest new projects. Cohen *et al*. (2002: 6) present two graphs comparing the different information sources to complete and suggest new R&D projects. For suggesting new projects clients were considered the most important sources. Universities and public labs appear in the six position (there are 7 options for information sources), embracing 31.6% of answers. Only in drugs industry clients aren't considered the most important source to suggesting new projects.

For completing R&D projects firms' own manufacturing operations were the more important source, embracing 78% of answers. Universities and public labs appear in fifth position, responding for 36% of answers. For drugs, auto parts and aerospace industries public researches were considered the most important information source for completing R&D projects (55% of answers).

It was observed that principal channels of information exchange between universities and firms were publications and reports (41.2), informal interaction (35.6) and meetings and conferences (35.5). However the relevance of these channels were distinct between industrial sectors. For example, in basic chemicals informal interactions (39.0) were the principal channel for information exchange being followed by reports/ publications (36.6) and consulting (34.2). In medical equipments, informal interactions (47.3) were also the most important channel being followed by consulting (44.6) and reports/ publications (40.5)

2 - THE DATABASE

CNPq is a 50-year-old organization of the Brazilian Ministry of Science and Technology responsible for distributing research grants to the Brazilian scientific and technological communities. Its Directory of Research Groups is a database that started to be collected in the early nineties and is renewed every second year. It comprises detailed information about research activities in Brazil using the ´research group' as the unity of analysis. The directory provides an excellent proxy for studying research activities in Brazil, even though the adherence to it is voluntary. Since 2002 interaction with the productive sector was introduced in the questionnaire to be answered by leaders' groups. Although there are intrinsic limitations to information collection, the database supplies some important evidence from recent university-industry interactions in Brazil.

This work follows the methodology developed in Rapini's (2007) work and uses the database construct for the following projects: (1) "Interações de Universidades e Institutos de Pesquisa com Empresas no Brasil" from CNPq (in Brazil); (2) "Interactions between universities and firms: searching for paths to support the changing role of universities in Latin America" from IDRC; (3) "Interações de universidades/instituições de pesquisa com empresas industriais no Brasil" from FAPESP/ Brazil.

The data base methodology proposes 14 types of possible relations between groups and firms. Each leader could list at most 3 types of relationship that were more frequent with firms. Research groups to firm's relationships could be of 9 different types. Firms to group relationships could be of 4 kinds. There were no relevant criteria or scale, so a comparison with other key studies (such as Meyer-Kramer e Schmoch, 1998; Klevorick *et al*., 1994; Cohen *et al*., 2002) is not possible. Box 1 brings a list of possible relationships between groups and firms, and the ones with "*" could be bilateral relationships. The number 4 "supply of inputs and materials not linked to joint projects" was excluded in the subsequent analyses as they do not comprise collaborative relationship.

Box 1 - Types of relationships of Research Groups with Firms

1	Consultancy
2	Non-routine engineering (including prototype development and pilot plants and equipment development) *
3	Software development *
4	Supply of inputs and materials not linked to joint projects *
5	Scientific research (for immediate use of results)
6	Scientific research (not for immediate use of results)
7	Technology transference *
8	Training (including "on the job") *
9	Others

Source: CNPq Directory of Research Groups,2004

The firsts Census in CNPq's database were in 1993 and embraces 99 institutions, 4.402 research groups and 21.541 researchers as it is shown in Table I. The last available version is from 2004[4], and has 375 institutions, 19.470 research groups and 77.649 researches. In 2004, 19% of institutions concentrate near 75% of total research groups. Between 1993- 2004, we can observe a significant increase in the share of PhD among researcher. From total research groups only 2139 (11.1%), which are affiliated to 217 institutions, had declared any relationship with productive sector in 2004. The analysis will concentrate on these groups and in the information provided by them.

Table 1: Number of institutions, research groups, researches and PhD researchers, Brazil, 1993 - 2004.

	1993	**1995**	**1997**	**2000**	**2002**	**2004**
Institutions	99	158	181	224	268	375
Groups	4.402	7.271	8.632	11.760	15.158	19.470
Researchers (P)	21.541	26.799	34.040	48.781	56.891	77.649
PhD researches (D)	10.994	14.308	18.724	27.662	33.947	47.973
(D)/(P) in %	51	53	55	57	60	62

Source: CNPq's Directory of Research Groups.

[4] The 2006 Census is not fully available in CNPq's website.

3 - UNIVERSITY-INDUSTRY INTERACTIONS IN BRAZIL

State Level

The 2.139 research groups that declared some relationship with productive sector are located in 24 brazilian states and in Distrito Federal[5]. Table 2 shows the distribution of research groups (total and interactive) and units of productive sector in state level. Regional inequalities identified in technical-scientific production and in innovative activities (Barros, 2000; Albuquerque *et al.*, 2002) are replicated in university-firms interactions.

Table 2: Research groups, total and interactive, productive sector units, interaction level and density, by brazilian state, Brazil, 2004.

Brazilian state	Groups (a)	Interactive groups (b)	Interaction level (b)/(a)	Productive sector (units) (c)	Interaction density (c)/ (b)
Acre	25	1	4,00%	6	6,00
Alagoas	133	10	7,52%	12	1,20
Amapá	10	0	0,00%	0	---
Amazonas	289	28	9,69%	24	0,86
Bahia	728	111	15,25%	163	1,47
Ceará	423	52	12,29%	82	1,58
Distrito Federal	477	61	12,79%	98	1,61
Espírito Santo	200	16	8,00%	28	1,75
Goiás	266	43	16,17%	75	1,74
Maranhão	119	14	11,76%	16	1,14
Mato Grosso	171	19	11,11%	28	1,47
Mato Grosso do Sul	225	11	4,89%	13	1,18
Minas Gerais	1694	226	13,34%	367	1,62
Pará	286	52	18,18%	57	1,10
Paraíba	329	36	10,94%	46	1,28
Paraná	1512	183	12,10%	347	1,90
Pernambuco	602	87	14,45%	149	1,71
Piauí	101	3	2,97%	18	6,00
Rio de Janeiro	2786	259	9,30%	329	1,27
Rio Grande do Norte	220	24	10,91%	40	1,67
Rio Grande do Sul	2072	265	12,79%	417	1,57
Rondônia	33	0	0,00%	0	---
Roraima	30	2	6,67%	2	1,00
Santa Catarina	996	163	16,37%	290	1,78
São Paulo	5541	464	8,37%	746	1,61
Sergipe	105	15	14,29%	15	1,00
Tocantins	97	6	6,19%	8	1,33
Total	19.470	2.151	11,05%	2.768	1,29

Source: CNPq's Directory of Research Groups, 2005, author's elaboration.

[5] Two Brazilian states, Rondônia and Amapá, don't have any research group interacting with firms, so they aren't on the database.

São Paulo has the higher number of research groups (5.541) and also the higher number of interactive research groups (945). The second position is occupied by Rio de Janeiro, with 2.786 research groups, and the third by Rio Grande do Sul, with 2072 groups. In terms of interactive research groups, the positions are inverted and Rio Grande do Sul is in second (265) and Rio de Janeiro in third (259).

The table also shows two proposed indicators: interaction level (total interactive research groups / total research groups) and interaction density (total units of productive sector / total interactive research groups). The interaction level in Brazil was 11.05%. The states with elevated interaction level were Para (18, 18%), Santa Catarina (16.37%) and Goiás (16.17%). In São Paulo this indicator was 8.37%, being bellow the national average. In Brazil, the interaction density was 1.29 units of productive sector per research group. The highest indicators were in Piauí (6.0%) and Acre (6.0%), but theses states have a small number of interactive research groups. It's important to mention that productive sector units could be or not be located in the same state of the research group. For example, 48% of productive sector units that interacted with research groups from Minas Gerais' institutions were located outside the state (Righi, 2005), and in São Paulo, the same were for 21.7% of productive sector units (Righi & Rapini, 2007).

Knowledge field

Mowery and Sampat (2005) highlighted that university-industry interactions are specific to each sector of activity, and this specificity should be taken in account in U-I investigations. The distinct knowledge areas, for sure, shows specific U-I interactions that is relevant to understand the database.

The research groups are classified in terms of knowledge field. In CNPq these fields cover broad areas, as Engineering, Agricultural Sciences, Exact and Earth Sciences, Biological Sciences, Health Sciences, Humanities. Table 3 shows the distribution of research groups (total and interactive) and the units of productive sector in each knowledge field. The knowledge fields with higher interactive level were Engineering (26.4%) and Agricultural sciences (21.7%). The first case was in some way expected, as it comprises an area traditionally close to industrial practices. The second reflects the Brazilian specialization in agroindustry, some specificities of technology diffusion and the long-range public efforts to develop and diffuse agricultural technology since the 1960s.

Then are Exact and earth sciences (10.11%), Biological sciences (8.75%) and Health sciences (7%). Humanities come in the last position with 4.18%. Worrying are the performances from health and biological sciences, as being areas of national competence and the presence of recent potential partnership with productive sector as in biotechnology related areas. These points that productive sector should take more advantage of the technology opportunities offered by national science and technology infra-structure (Cassiolato *et al.*, 1996).

In interaction density indicator the highest number were Engineering (1.74), Agricultural sciences (1.58) and Humanities (1.56), what reflects a higher diversification in collaborative relationships with productive sector. For humanities, the literature points to increasing university interactions with firms from service sector. (Schartinger *et al.*, 2001). The engineering field embraces 44% (or 4.313) of total collaborative relationships and the agricultural sciences 22% (2.171).

Table 3: Research groups (total and interactive), productive sector units, interaction level and density by knowledge fields, Brazil, 2004.

Knowledge field	Groups (a)	Interactive groups (b)	Total relationship	Interaction level (b)/(a)	Productive sector unit (c)	Interaction density (c) / (b)
Engineering	2826	747	4.313	26.43%	1.301	1,74
Agricultural science	1997	434	2.171	21.73%	684	1,58
Exact and Earth Sciences	2454	248	908	10.11%	335	1,35
Heath sciences	3371	236	676	7.00%	270	1,14
Biological sciences	2561	224	767	8,75%	319	1,42
Humanities	6261	262	827	4.18%	411	1,56
Total	19.470	2.151	9.052	11.05%	2.768	1,29

Source: CNPq's Directory of Research Groups, 2005, author's elaboration.

Table 4 shows the distribution of each type of relationships (described in Box 1) in the knowledge fields. The more frequent relationships were: scientific research with immediate use of results (2731 or 30% of total relationships); technology transference (1762 or 19% of total relationships); and scientific research without immediate use of results (1412 or 16% of total relationships). Consultancy and training appear in the fourth position embracing each near 9% of total relationship.

In agricultural sciences, health sciences and humanities training were more frequent than consultancy, and in exact and earth science the opposite happens. Scientific research without immediate use of results was more frequent than technology transference in biological sciences and in humanities. No routine engineering and software development were more relevant in engineering.

Table 4: Total number of types of relationship by knowledge field, Brazil, 2004.

Type of relationships	Agricultural science	Biological sciences	Health sciences	Exact and Earth Sciences	Engineering	Humanities	Total
Scientific research (not for immediate use of results)	323	158	113	155	515	148	1412
Scientific research (for immediate use of results)	622	230	193	275	1.192	219	2731
No Routine engineering (*)	43	10	10	54	375	9	501
Software development (*)	33	8	9	23	351	36	460
Technology transference (*)	510	141	104	159	744	104	1762
Consultancy	134	62	58	90	343	85	772
Training (*)	222	49	74	64	323	102	834
Others	104	60	54	53	215	94	580
Total	**1991**	**718**	**615**	**873**	**4058**	**797**	**9052**

Note: (*) billateral relationships
Source: CNPq's Directory of Research Groups, 2005, author's elaboration.

Firm Size

Research group's leader also informed about some productive sector characteristics. In Census 2004, the 2151 research groups interacted with 2768 units of productive sector. In other to check the information two steps were realized by authors: (1) online searches in *Receita Federal* website (Brazilian Ministry of Finance) to verify the sector of activity of each productive unit; (2) cross consultancy in Brazilian Ministry of Labor database to check information regarding the number of employees in each productive unit. After this two steps 2494 units of productive sector remained and their features will be presented in this section.

Table 5 shows the distribution of types of relationship by productive sector unit size. For the size it was used *Sebrae's* classification: micro enterprise with until 19 employees, small firms with 20-99 employees, medium firms with 100-499 employees and large firms with more than 500 employees. The micro enterprises embrace 662 firms (or 26.6% of total firms), small firms 531 (or 21.3% of total firms), medium firms 736 (or 29.5%) and large firms 568 (or 22.8%). The large firms respond for almost 35% (2493) of total relationships and medium firms for 30% (2001). Training was more relevant for large firms and consultancy for small and medium firms. Medium firms frequently used technology transference.

Table 5: Total number of types of relationship by productive sector unit size (number of employees), Brazil, 2004.

Type of relationships	Micro enterprise	Small	Medium	Large	Total
Scientific research (not for immediate use of results)	184	178	296	347	1005
Scientific research (for immediate use of results)	389	328	628	795	2140
No routine engineering (*)	83	68	84	82	317
Software development (*)	60	38	85	110	293
Technology transference (*)	305	246	471	412	1434
Consultancy	110	91	158	177	536
Training (*)	110	76	150	210	546
Others	91	67	129	166	453
Total	**1332**	**1092**	**2001**	**2299**	**6724**
Number of firms	662	531	736	568	2493

Note: (*) billateral relationships

Source: CNPq's Directory of Research Groups, 2005, author's elaboration.

Spots of interactions

These data presents an overall picture of interactions between sectors and S&E fields, according to the interactive research group point of view. So, it is possible to identify spots of interaction in Brazil[6]. Analyzing the number of research groups (of that specific S&E field) and the number of firms (of that specific sector) with interaction, it is possible to consider three factors: 1) the most important interactive S&E fields (research groups); 2) the most relevant interactive sectors (firms/institutions); 3) the identification of spots of interactions (S&E fields and sectors with a stronger relationships than others).

First, it is identified the most relevant S&E fields. In this way, for example, Agronomy presents the most interactive groups, highlighting five sectors: agriculture, R&D, public administration, associations and retailing. Others remarkable interactive S&E fields are Electric Engineering, Metallurgical and Material Engineering, Civil Engineering and Computer Science. Then, it should be analyzed the most interactive sectors. It can be stand out public administration, associates, R&D. It's important to emphasize that the industrial sectors just appear in sixth with Chemicals[7].

[6] This table was inspired on Table 3 (p. 11) presented on Cohen et al. (2002), that summarizes the results from Carnegie Mellon Survey. They present the "the percentage, by industry, of respondents scoring each of the fields at least 'moderately important'".

[7] Here it's important to highlight that the database includes all kind of institutions that the research group leader declared to have any type of relationship. Unfortunately, the database doesn't include just industrial sectors.

Table 6: Science & Engineering Fields and ISIC sectors, by research groups and firms with interaction, Brazil, Census 2004

Sectors		Adm.	Agron.	Architec.	Biochemistry	Bot.	Computer Science	Food S&T	Ecology	Education	Nursing	Agriculture Eng.	Civil Eng.	Material and Metalurgy Eng.	Minning Eng.	Production Eng.	Electr. Eng.	Mechanical Eng.	Chemica Eng.	Sanitary Eng.	Pharmacy	Physics	Genetics	Geoscience	Medicine	Microb.	Oceanog.	Dentistry	Psychology	Chemistry	Forest Eng.	Fishing Eng.	Collective Health	Zool.	Zootec.	Vet.	Others	Total
1+2+3	Agriculture, Fishing	/	50/43	/	1/1	3/3	1/2	5/6	3/3	/	/	6/5	1/1	5/4	/	2/2	/	5/3	2/2	/	/	/	4/6	/	/	1/2	1/1	/	/	1/2	16/20	6/6	/	1/2	12/13	4/6	7/7	**137/140**
7	Metallic Mining	/	1/1	/	/	/	/	1/1	2/3	/	/	/	2/2	4/5	1/2	/	1/1	/	/	/	/	/	1/1	8/9	/	1/1	/	/	/	1/1	3/2	/	/	/	/	/	2/2	**28/31**
8	Non-Metallic Mining	/	/	/	/	/	/	/	/	/	/	/	5/5	5/12	5/7	/	/	/	/	1/1	/	1/1	/	3/3	/	/	2/2	/	/	2/2	1/1	/	/	/	/	/	1/1	**26/35**
10+11	Food	/	14/23	/	3/4	2/3	1/1	26/44	2/2	1/1	/	1/2	/	1/1	3/3	10/6	2/2	/	8/9	1/1	1/1	/	2/4	/	/	5/7	3/3	1/1	/	6/7	2/2	2/3	1/1	1/1	11/13	8/14	7/7	**125/166**
17	Cellulose and Paper	1/1	7/8	/	/	/	/	2/2	1/1	/	/	1/2	1/1	/	/	4/2	1/2	/	2/2	/	/	/	3/9	/	/	1/1	/	/	/	3/3	17/20	/	/	/	/	/	3/3	**47/57**
19	Refined Petroleum and Nuclear Fuels	/	3/12	/	/	1/1	/	1/1	3/3	1/1	/	1/1	1/1	4/4	1/1	1/1	3/4	5/4	3/3	1/1	/	/	3/5	5/6	/	1/1	/	/	/	/	/	1/1	/	/	/	/	1/1	**40/52**
20	Chemicals	1/1	12/13	/	2/2	/	/	5/4	1/1	/	/	/	5/6	17/41	1/3	6/4	/	6/7	23/38	3/5	3/3	2/2	2/2	1/1	3/2	3/4	/	3/3	/	26/30	2/2	2/1	/	1/1	4/4	/	6/7	**140/187**
21	Pharmaceutical Products	3/3	/	/	6/10	2/2	/	/	/	/	/	/	/	2/2	/	/	/	1/1	3/2	/	16/34	/	2/2	/	8/9	1/4	/	/	/	11/13	/	/	/	/	6/7	10/10	16/20	**87/119**
22	Rubber and Plastic	/	/	1/1	/	/	/	3/4	/	/	/	/	6/8	10/37	/	1/1	/	4/3	2/2	3/3	/	/	/	/	/	/	/	/	/	1/1	/	1/1	/	/	/	2/2	1/1	**35/64**
23	Non-Metallic Mineral Products	2/2	/	/	/	/	/	1/5	/	/	/	/	12/22	15/48	2/2	2/2	1/1	2/2	/	/	/	1/1	/	1/1	/	/	/	/	/	1/1	/	/	/	/	/	1/1	0/0	**41/88**
24	Basic Metallurgy	/	3/2	1/1	/	/	1/1	/	/	/	/	1/1	8/7	32/42	1/1	5/6	5/7	9/9	3/4	1/1	/	/	/	2/2	/	/	1/1	/	/	2/2	1/1	/	/	/	/	/	1/1	**77/89**
25	Metal Products	/	/	/	/	/	/	1/5	/	/	/	1/1	7/6	16/31	/	4/3	1/1	11/11	2/2	/	/	1/1	/	/	/	/	/	/	/	1/1	/	/	/	/	/	/	4/4	**49/66**
26	Computer Equipments, Eletric and Opto	/	/	/	/	/	21/21	/	/	/	/	2/2	/	4/7	/	2/2	27/38	4/4	/	/	/	4/7	/	1/1	/	/	/	1/1	/	2/2	/	/	1/1	/	/	1/1	7/6	**77/93**
27	Electrical and Electronic Machinery	/	1/1	/	/	/	4/3	/	/	/	/	1/1	2/2	7/20	/	/	16/18	9/9	1/1	/	/	1/1	/	/	1/1	/	/	/	1/1	2/2	/	/	/	/	/	/	3/3	**49/63**
28	Machinery	/	2/2	/	/	/	1/1	5/5	/	/	/	8/13	3/3	13/27	/	3/5	5/5	10/11	4/4	2/2	/	2/2	/	/	/	/	/	/	/	3/3	/	/	/	/	/	/	2/3	**63/86**
29	Car/Truck	/	/	/	/	/	/	/	/	/	/	/	/	17/32	/	8/7	1/1	13/8	/	/	/	/	/	/	/	/	/	/	1/1	1/1	/	/	/	1/1	/	/	1/1	**43/52**
32	Other products	/	/	/	2/2	/	/	/	/	/	/	/	1/1	7/15	/	1/1	2/2	/	/	/	/	4/5	1/1	/	2/1	1/1	/	9/12	/	2/5	/	/	/	/	/	1/1	9/10	**42/57**
35	Electricity, Gas and Others	3/3	4/2	1/1	/	/	8/9	1/1	10/10	2/2	/	2/2	12/13	5/25	/	4/2	52/53	19/19	3/4	2/2	/	/	1/1	6/7	/	/	2/1	/	1/2	3/3	3/3	1/1	/	2/3	1/1	1/1	15/13	**164/184**
36+37+38	Sanitation	/	5/5	/	/	2/2	/	/	5/4	/	/	2/2	6/5	4/6	/	/	1/1	2/1	3/3	14/12	/	/	/	6/5	/	/	1/1	/	/	4/4	/	1/1	/	/	/	/	4/5	**60/57**
46+47	Comerce	4/3	22/22	1/1	6/5	2/2	11/9	5/5	3/3	1/1	1/1	8/9	9/10	15/24	/	10/8	8/9	13/14	6/6	1/1	2/2	7/6	4/2	5/4	2/2	2/4	2/2	4/4	/	7/7	/	1/1	/	1/1	6/8	5/5	16/15	**188/194**
62	IT Services	4/4	/	/	/	/	29/38	/	/	3/3	/	/	2/2	1/1	/	5/7	12/15	2/1	/	/	/	1/1	/	2/5	2/2	/	/	/	1/1	/	1/1	/	/	/	1/1	1/1	10/9	**77/92**
64	Financial Services	4/3	1/2	4/4	/	/	2/1	/	1/1	/	/	/	8/7	1/1	3/3	2/2	10/10	5/4	4/2	/	/	2/2	/	1/1	/	2/1	1/1	/	2/3	/	/	1/1	/	/	2/2	/	9/10	**65/61**
71	Architecture and Engineering	/	2/2	1/1	/	/	1/1	/	4/5	/	/	/	10/10	5/10	2/2	1/1	2/2	4/4	5/6	6/7	1/1	3/3	/	10/14	/	/	3/4	/	/	4/3	1/1	1/1	/	/	1/1	/	12/15	**79/94**
72	Scientific R&D	5/5	39/33	/	1/1	6/12	7/7	8/6	6/5	2/2	/	7/9	4/4	6/7	2/2	3/3	17/11	9/5	5/4	2/1	1/1	6/5	7/10	22/18	2/2	3/3	8/6	/	/	12/10	8/3	4/4	1/1	3/3	8/7	7/5	22/20	**243/215**
82	Office Services	2/3	8/6	/	1/1	/	3/3	1/1	2/2	/	/	/	1/1	1/1	/	/	10/4	3/4	3/3	/	4/3	1/1	/	2/2	2/2	1/1	1/1	/	/	1/1	1/1	/	/	2/1	/	/	13/12	**63/54**
84	Public Administration	5/5	31/34	5/8	/	5/5	6/8	6/4	12/14	6/7	4/6	4/7	15/14	6/7	1/1	7/5	7/9	5/10	5/4	11/15	4/4	3/3	4/4	14/20	4/4	6/5	6/7	1/1	3/5	6/9	2/2	2/2	12/19	5/7	8/9	5/5	41/59	**267/328**
85	Education	5/6	20/24	2/4	1/1	3/3	4/3	4/4	6/5	11/13	11/11	1/1	3/4	6/7	/	8/12	4/4	3/3	2/2	1/1	1/1	/	1/4	5/6	10/8	4/6	1/1	1/1	6/7	3/4	1/1	1/2	6/9	3/3	7/8	2/2	43/41	**190/212**
86	Health and Biotechnology	1/1	/	/	2/2	/	2/2	/	1/1	/	4/7	/	/	4/4	/	2/3	1/1	2/2	1/1	/	1/1	5/9	3/3	/	41/32	2/2	/	6/7	1/1	3/3	/	/	4/4	/	/	5/5	19/20	**110/111**
94	Others Organizations	6/14	32/38	1/1	/	3/3	7/9	7/7	6/7	9/14	3/4	4/5	17/20	9/18	3/4	9/14	8/7	4/5	9/7	3/3	2/2	/	3/4	10/10	15/12	2/2	3/3	/	4/4	4/3	6/9	2/3	4/4	3/3	8/8	5/6	37/43	**248/296**
Others		20/19	32/22	10/8	3/2	2/2	28/19	13/7	15/9	13/9	4/3	4/6	47/49	53/56	6/7	24/22	39/32	39/31	26/23	9/7	7/3	4/4	5/7	26/21	9/3	4/3	6/6	3/1	12/9	17/9	23/18	4/4	11/9	6/4	11/10	12/5	309/100	**547/549**
Total		**36/73**	**170/295**	**17/30**	**21/31**	**18/36**	**87/138**	**50/112**	**44/79**	**38/53**	**23/32**	**26/69**	**88/204**	**95/496**	**11/38**	**48/121**	**121/240**	**88/176**	**56/134**	**34/63**	**32/56**	**32/54**	**23/65**	**72/136**	**77/80**	**25/48**	**25/40**	**24/31**	**18/34**	**84/132**	**36/87**	**14/32**	**26/48**	**19/30**	**43/92**	**51/70**	**307/338**	**2151/3068**

Source: CNPq Directory of Research Group, Census 2004, author´s elaboration.

And, finally, it can be studied the intersection between the S&E fields and sectors to find the spots of interactions. In other words, it is possible to find where the relationship between S&E fields and sectors is in fact working in the country. Considering those points that presents more than 30 research groups or 30 units of productive sector, it can be located 18 spots of interactions including 9 S&E fields and 16 sectors. The most relevant spots of interactions are: Electrical Engineering and Electricity, Gas and others (52 research groups and 53 units of productive sector); Agronomy and Agriculture, Livestock and Fishing (50 research groups and 43 units of productive sector); Medicine and Human Health (41 research groups and 32 units of productive sector).

It is important to notice that on Cohen et al. (2002) the similar table (Table 3, p.11) doesn't have lots of empty spaces, as it's remarkable on Brazilian case. This reflects the disconnection between these two actors into the Brazilian NSI.

Despite the fact that it's noticeable that Brazil presents an incipient relationship between universities and firms, it's important to observe that for some S&E fields and some sectors this interaction works. This could be understood as a beginning of a dialogue between these spheres, and soon helps Brazilian science and technology development process.

4- CONCLUSION

The objective of this paper was to map the university-industry interactions using data from CNPq' Directory. As it was stressed before, despite its problems, this database presents a mapping of this relationship and it can be a tool to be used on the investigation of this issue. This data is the starting point of the projects mentioned before on page 4. From this tool it was possible to identify interactive firms and research groups to further investigations.

As was presented the distribution of research groups (total and interactive) and of units of productive sector in state level replicates regional inequalities identified in technical-scientific production and in innovative activities.

The knowledge fields with higher interactive level were Engineering (26.4%) and Agricultural sciences (21.7%). There are a lot that can be done in fostering university-firms interactions in biological and health sciences that are areas of national competence and presents recent potential partnership in biotechnology related area.

The more frequent relationships were scientific research with immediate use of results, technology transference and scientific research without immediate use of results. The relevance of relationships, of course, varies between each knowledge area. In agricultural sciences, health sciences and humanities training were more frequent than consultancy, and in exact and earth science the opposite happens. Scientific research without immediate use of results was more frequent than technology transference in biological sciences and in humanities. No routine engineering and software development were more relevant in engineering.

In terms of firm size the large firms respond for almost 35% of total relationships with research groups and medium firms for 30%. Training was more relevant for large firms and consultancy for small and medium firms. Medium firms frequently used technology transference.

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